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RESIDUAL WOOD AFTER LOGGING

IN THE

LARCH-DOUGLAS FIR

&

LODGEPOLE PINE TYPES

by

I. V. ANDERSON

Associate Forester.



NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
MISSOULA, MONTANA

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RESIDUAL WOOD AFTER LOGGING
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An Inventory Classification and Analysis of
Unused Wood Left on Logged-over Areas

By

I. V. Anderson
Section of Forest Products

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FOREWORD

This same subject has been covered in two previous reports in which the author made an analysis of residual wood after logging in the western white pine and ponderosa pine types of western Montana and north Idaho. The purpose of this article is to cover a similar field for the (1) larch-Douglas fir type of northwestern Montana and the lodgepole pine type of southwestern and central Montana. Identical study methods were used in all three studies so the results are comparable. In making comparisons it should be recognized that wood losses in logging vary with the volume of the stand per acre, utilization standards and especially the class of material being manufactured from the trees. Most of the areas studied in the lodgepole pine type had been logged for hewed ties. A standard tie cannot be hewed from a stick having a top diameter of less than 9 inches. Consequently the unusable wood residue after logging in this timber type is high, considering the small volume logged per acre. All wood losses after logging in the four forest types studied compare as follows:

Western white pine type 1,322 cubic feet (14.5 cords)

Ponderosa pine type 436 cubic feet (4.8 cords)

- (1) Western larch - scientific name Larix occendtalis.
Douglas fir - scientific name Pseudotsuga taxifolia.
Lodgepole pine - scientific name Pinus contorta.

Larch-Douglas fir type 935 cubic feet (10.4 cords)

Lodgepole pine type 829 cubic feet (9.2 cords)

Thus, wood losses in logging the ponderosa pine type are the least of all four types studied. During the normal year, approximately 12,000 acres of the larch-Douglas fir type are cut over in Montana. This is not quite half the area logged in either the western white pine and ponderosa pine types.

These 12,000 acres of larch-Douglas fir forest cut over annually produce 125 million feet of sawlogs which are manufactured into lumber and timbers valued at 2 $\frac{1}{2}$ million dollars.

The annual cut-over acreage in the lodgepole pine type is the least of all four types. Only 2,140 acres of the lodgepole pine type are cut over annually in southwestern and central Montana for commercial products such as ties and mining timbers. However, the exploitation of the lodgepole pine and larch-Douglas fir types has only started. At present the standing timber in the two types amounts to approximately 43 billion feet. A volume sufficient to justify the study and development of better utilization practices if this timber is to be exploited wisely.

The terms usable and nonusable wood are used frequently throughout this article. Wood material is considered usable if it will yield a merchantable product suitable for lumber production or miscellaneous timber products such as ties and stulls as determined by utilization practices prevailing in 1929. Field work for this study was done in 1930.

All other wood material on the ground resulting from logging and dead sound material is considered as nonusable and as being unmerchantable at the present time.

The results of the survey in the larch-Douglas fir and the lodgepole pine types are summarized by the following conclusions:

CONCLUSIONS OF STUDY

LARCH-DOUGLAS FIR TYPE

1. Seventy-nine (79) per cent of the average western larch tree logged in western Montana and north Idaho is cut into sawlogs. Thus, 21% of the tree is not utilized in the woods compared to 10% of the tree not utilized in the sawmill.

2. Ninety (90) per cent of the average Douglas fir tree logged in western Montana and north Idaho is cut into sawlogs. Thus, 10% of the tree is not utilized in the woods compared to 12% of the tree not utilized in the sawmill.

3. The usable wood of small sawlog size on the average acre logged in the larch-Douglas fir type amounts to 283 feet net log scale (2) per acre of all species. This is a little more than in the ponderosa pine type where this same wood loss amounts to 254 feet and considerably less than the same loss in the western white pine type where it amounts

(2) Scribner Decimal C log rule is implied wherever log scale is mentioned.

to 815 feet. This class of wood loss is naturally more in the western white pine type since a larger volume is logged per acre.

4. For the average acre logged in the larch-Douglas fir type during 1929 there was a usable wood loss of 266 and 125 board feet net log scale per acre, respectively, of western larch and Douglas fir. This made a total of 391 feet for larch and Douglas fir.

5. This 391 feet of material was distributed, 224 feet to logs overlooked in skidding or left in smooth straight tops, and 167 feet to loss in stumps (excessively high stumps free from shake and otherwise 50% more sound).

6. One hundred and four (104) cubic feet of larch long-butt material was found on each acre of logged-over area in the larch-Douglas fir type. This would make 1.2 cords of material suitable for galactan extraction, a chemical used in the manufacture of baking powder, effervescent drinks and pharmaceutical preparations.

7. Fifty-five (55) cubic feet of larch stump material was found on each acre of logged-over area in the larch-Douglas fir type. This would make .6 cords of material suitable for galactan extraction. It could be secured by cutting larch trees to an average stump height of 7 inches. This amount, .6 cords, with the 1.2 cords of long-butts makes a total of 1.8 cords of this class of material.

8. The combined usable and nonusable wood losses by species per acre is as follows:

a.	Larch	- - - - -	480	cu.ft.	-	5.4	ords
b.	Douglas fir	- - - - -	216	" "	-	2.4	"
c.	Lodgepole pine	- - - - -	163	" "	-	1.8	"
d.	Other	- - - - -	76	" "	-	.8	"
	Total	- - - - -	935	" "	-	10.4	"

9. The combined usable and nonusable wood loss of 480 cubic feet of western larch per acre is distributed (1) 104 cu. ft. (1.2 cords) of long-butts; 250 cu. ft. (2.8 cords) of sound wood in tops, dead material and cull logs; 80 cu. ft. (.9 cords) of sound wood in dead standing trees; 26 cu. ft. (.3 cords) in small sawlog material overlooked in skidding or left in smooth straight tops; and 20 cu. ft (.2 cords) of sound material in stumps cut excessively high.

10. Woods cull on the areas studied amounted to 15% for larch and 6% for Douglas fir. The high cull per cent for larch is due to the practice of long butting. Breakage and landing cull per cent are not included.

11. The average western larch stump on the study areas was 27 inches in height. The average Douglas fir stump was 21 inches in height.

12. Defective larch and Douglas fir stumps averaged 26.7 and 21 inches in height respectively. Defective stumps were cut lower than sound stumps.

13. Eighty-four (84) per cent of the western larch stumps on the study areas were classed as defective. Shake and check was the principal defect.

14. For every 1,000 feet of western larch logged on the study areas 38 feet of usable material was lost in small sawlog material and high stumps. A similar loss of 55 feet was found for Douglas fir.

15. A total of 10.1 snags per acre was found on the study areas compared to 13.8 per acre and 1.8 per acre, respectively, on the western white pine and ponderosa pine study areas.

16. Residual stands in the larch-Douglas fir type of western Montana are well worth protection from fire.

A total of 42 trees 8 inches in d.b.h. and over were found per acre on the study areas. Eleven (11) of these were larch and 20 were Douglas fir. Besides these, 33 larch and 80 Douglas fir trees of pole size and smaller were found.

LODGEPOLE PINE TYPE

1. Usable sawlog material remaining on the ground after logging in the lodgepole pine type is negligible unless trees are long-buttet for subsequent utilization in a portable tie mill.

2. On an operation where trees containing butts too large for hewed ties were long-buttet for subsequent skidding to a portable sawmill, 663 feet of lodgepole pine logs were found per acre.

3. The average acre of cut-over land in the lodgepole pine study contained 564 cu. ft. (6.2 cords) of green tree

wood, mostly tops and a few long-butts, compared to 524 cu. ft. (5.8 cords) and 208 cu. ft. (2.3 cords), respectively, in the larch-Douglas fir and ponderosa pine studies.

4. The average acre of cut-over land in the study contained a total of 644 cubic feet (7.2 cords) of material on the ground of minimum dimensions of 4 feet long and 4 inches in middle diameter outside the bark. This was composed of tops, long-butts, a small amount of sound dead material and trees knocked down during the felling operation.

5. The total nonusable wood loss per acre amounted to 825 cubic feet (9.2 cords) principally lodgepole pine. This, plus the usable loss of 4 cubic feet makes a combined usable and nonusable wood loss resulting from logging of 829 cubic feet or 9.2 cords.

6. The average acre of cut-over land in the lodgepole pine study contained 952 linear feet (240 cubic feet) of usable prop material, 580 linear feet (66 cubic feet) of usable lagging and 2½ ties. This material was found in tops and other material on the ground as a result of the cutting operation.

7. The study indicated that 4 linear feet of prop material and 1 linear foot of lagging remained on the ground for each tie removed from the area.

8. The woods cull on the area studied amounted to 10% for lodgepole pine. Breakage (negligible) and landing cull per cent are not included in this figure.

9. The average lodgepole pine stump on the study areas was 9.8 inches in height. The Forest Service specifies a maximum allowable stump height of 12 inches and on the Forest Service area studied stumps averaged 10.3 inches in height.

10. There was a usable lodgepole pine wood loss of only 15 feet, due to stumps cut excessively high.

11. Residual stands on the average acre studied contained 123 lodgepole pine trees 5 inches in d.b.h. and over having a net volume of 4470 feet log scale, Scribner Decimal C rule, or 1566 cu. ft. gross (equivalent to 17.4 cords).

12. Residual stands on the average acre studied contained a total of 125 trees of all species 5 inches d.b.h., and over, with a net volume of 4527 feet log scale or 1584 cubic feet gross (equivalent to 17.6 cords). Conclusions 11 and 12 are based upon hewed tie operations only.

STUDY METHODS AND MATERIAL INVOLVED

The study was made during the summer of 1930 on areas logged the summer of 1929 and the winter of 1929 and 1930. Operations in both the larch-Douglas fir and lodgepole pine types have been quite limited during the past 8 years. Therefore, very many camps were not included in the study. A total of 140 one-fifth acre plots, or 28 acres, were tallied in the larch-Douglas fir study at five separate camps in western Montana. Sixty-four (64) one-fifth acre plots, or 12.8 acres, were tallied in the lodgepole pine study at five separate camps in south central Montana.

The mechanics of the inventory were identical with those of the work done in the western white pine types. A complete description of the field procedure of the study is covered in the report giving the results of the inventory in the western white pine type (3). The following classes of material were measured in both larch-Douglas fir and lodgepole pine studies.

SAWLOGS. Minimum size specifications for a piece of material tallied in this group were 10 feet in length and 8 inches in diameter (small end) for larch-Douglas fir and other species in the larch-Douglas fir type except lodgepole pine. The minimum size specification for this species was 8 feet in length and 6 inches in diameter (small end). In the lodgepole pine type no material was tallied as suitable for sawlogs except for that study area designated as "Forest Service - Madison National Forest" in Supplemental Table 2, parts 1 and 2. Logs overlooked in skidding and contained in smooth and straight tops not bucked by the sawyers were listed under net scale unless the percentage of defect was more than 66-2/3% for ponderosa pine and 50% for other

- (3) Copies may be secured from the Director, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.
- ° Supplemental tables may be obtained from the Director, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.

species. In the case of cull logs the entire log scale was recorded under defective logs. The net cubic volume of cull logs was also recorded in the larch-Douglas fir study and is shown under column 14 of Supplemental Table 1, part 1. Coarse knotty top logs were excluded from the sawlog class and tallied as tree wood and computed on a cubic foot basis.

TREEWOOD. This class of material was measured and recorded in minimum length of 4 feet to a 4-inch middle diameter outside the bark. Short pieces of breakage were pieced together and measured and recorded in 4-foot lengths. Coarse knotty tops were included in this class.

DEADWOOD. Included dead sound material on ground.

LIMBWOOD. This class of material is negligible in both types.

LONG BUTTS. Any portion of the butt end of the tree ten feet and less in length bucked and left in the woods to eliminate defect was included under this classification. Butt logs over 10 feet in length cut off to eliminate defect were considered as cull logs and classified under sawlogs.

PROPS. Considered in lodgepole pine type only. Minimum size of a piece of material recorded under this class was 6 feet in length with a small end diameter of 5 inches. Very few pieces were less than 10 feet in length.

LAGGING. Considered in lodgepole pine type only. Minimum size of a piece of material recorded under this class was 6 feet in length with a small end diameter of 3 inches. Very few pieces were less than 10 feet in length.

TIES. The minimum size of a piece of material recorded was 8 feet in length with a small end diameter of 9 inches.

POLE & PILING. Confined to lodgepole pine study. Material classified according to Western Red Cedar Association grading rules. Nothing smaller than a 25-foot, 6-inch pole recorded.

STUMPS. Stump heights were measured on the side adjacent to the nearest ground. No stump waste was computed for excessive stump heights if the surface area of the stump was 50% or more decayed or if 1/6 of it was shaky or checked. Nor was waste credited to stumps cut high because of physical interference.

DEAD TREES. All snags of any species suitable for fuelwood were tallied as such and their cubic contents recorded. Unsound snags were merely counted.

LIVE UNCUT TREES. All species in the larch-Douglas fir study were estimated to and including 8 inches d.b.h., using a diameter tape for about 50% of the measurements. The defective volume of the residual stand was recorded by individual trees. In the lodgepole pine study the residual stand was cruised to and including trees of a minimum d.b.h. of 9 inches on one study area and to and including a minimum d.b.h. of 5 inches on the remainder of the areas.

REPRODUCTION. Tallied for only those areas indicated in the tables. Only those young trees of all species visible from the center of the plot or counted while tallying stumps and down material were recorded.

All data were placed on a one-acre basis in the office compilation. Comparisons were made on a one-acre basis as indicated in Supplemental Tables 1, 2, 3, and 4. Comparisons of residual stands in the various classes of operations in the two types are of particular interest in determining the future wood producing capacity of cut-over lands.

LOGS OVERLOOKED IN SKIDDING, and straight and smooth tops constitute a small loss in the larch-Douglas fir type.

Supplemental Table 1, part 1, column 9, shows how these losses vary by species on the different types of larch-Douglas fir logged-over areas. In the average western Montana camp this loss amounts to 148 feet of larch and 76 feet of Douglas fir per acre. During these times of low prices for larch and Douglas fir this loss is relatively unimportant. Nevertheless it constitutes a leak that is a contributing factor in the possible failure of an operation. A total of 8.9 logs per acre of all species were tallied under this classification in the larch-Douglas fir study. Of this amount 4.4 were western larch and 2.7 were Douglas fir. The scale of the average log in this classification is 45 feet for larch and 30 feet for Douglas fir.

No material of this classification was tallied in the lodgepole pine study except that shown in Supplemental Table 2, part 1, under the caption "Forest Service - Madison National Forest". On this area the butt end of any tree too large for hewing into ties was cut into sawlog lengths. These

logs were subsequently skidded to a portable tie mill. There were 663 feet of lodgepole logs per acre of this character on this area - or 224 feet of sawlogs for every 100 ties cut. Merchantable ties left on the area numbered $2\frac{1}{2}$ per acre, a negligible amount. Prop and lagging material listed in Supplemental Table 2, columns 17 to 20, while not exactly usable material at this time, is usable during boom periods in the mining industry. Fifteen years ago on and in the vicinity of the Deerlodge Forest lodgepole pine trees were utilized for props and lagging to a 5-inch and 3-inch small end diameter respectively. On the average acre in the lodgepole pine type logged for ties it is possible to remove 951 linear feet of props and 576 linear feet of lagging per acre in the same operation. Or in other words for each tie cut 4 feet of lodgepole pine material suitable for props and 1 linear foot of lodgepole pine material suitable for lagging are left on the ground. This abundance of wood material on the ground presents a most unsatisfactory appearance from a utilization standpoint. Nevertheless it is economically unavoidable.

EXCESSIVE STUMP HEIGHTS are an important source of usable wood loss in the larch-Douglas fir type. The elimination of this usable wood loss contained in high stumps is, however, a separate study in itself. The most important question to be answered is this. Does it pay to cut all larch-Douglas fir stumps to a maximum arbitrary stump height of 12 inches

in order to eliminate this usable wood loss and then long-butt the shaky material when necessary? Or, should an effort be made to eliminate shake and defect in the butt log by cutting an excessively high stump and long butt shaky material when not eliminated by the high stump? Eighty-five (85) per cent of the larch stumps and 50% of the Douglas fir stumps recorded in the study were defective. The principal defect was shake and check. With defect so prevalent it was a rather difficult matter to segregate the loss of usable material from the shaky and checked material. Any larch or Douglas fir stump showing shake over 1/6 of its top surface was not considered as having any usable material. Thus, there is little possibility that very much shaky and checked material was included in the usable wood loss.

The study showed a loss because of high stumps of 118 feet b.m. and 49 feet b.m. of high class wood material for larch and Douglas fir, respectively. The total loss from this source was 202 feet log scale of all species per acre. The average figures for western Montana show that both larch and Douglas fir sound stumps are cut higher than defective stumps. The opposite was found to be true of pine stumps in the study of the ponderosa pine type. The predominating defect in both larch and Douglas fir butts is shake and check, which usually extends farther up the tree in larch than in Douglas fir. Sawyers are of course aware of this fact. They

also know that frequency and intensity of these defects depend somewhat on the size of the tree. Shake and check are much more uncommon in trees 20 inches d.b.h. and less than in larger trees. Very frequently a three-foot stump in the smaller trees will clear out all of the shake and the worst part of the heart check. Thus, there is a tendency on the part of sawyers to cut stumps from 6 to 15 inches over the average height if they feel that the necessity of long-butt-ing is thereby eliminated. Stumps cut from 26 to 31 inches in height allow the sawyers to assume the most comfortable position at their work. Consequently most larch and Douglas fir stumps are cut in this height range. The woods run average stump height in the study was 27 inches and 21 inches, respectively, for larch and Douglas fir.

One inconsistency was encountered in computing the waste in the individual stump section. Waste volume was computed on the average diameter inside the bark and the average length of the wasted stump section. In reality, it should have been computed on the top diameter of the butt log cut from the tree. Stump wood losses were reduced by 10% to offset this inconsistency. The amount logged per acre on the study areas was computed from stump measurements. Before stump diameter could be converted to tree diameters breast height, it was necessary to establish the relationship between these two measurements. Tables showing how to

convert stump diameter inside the bark measurements were prepared for western white pine, ponderosa pine, western larch, Douglas fir and lodgepole pine. They may be secured from the Northern Rocky Mountain Forest Experiment Station, Missoula, Montana. The study indicated that the diameter breast high for larch trees was equal to the stump diameter inside the bark plus one inch for stump diameters (inside bark) from 10 inches to 30. Above that the variation in butt swell is so great that it is better to determine the d.b.h. for each tree individually in the field. The diameter breast high for Douglas fir trees equals the stump diameter plus one (1) inch for stump diameters, inside bark, from 10 inches to 33 inches. Where lodgepole pine stump heights average 8 to 12 inches in height as on tie sales in the vicinity of West Yellowstone, Montana, the stump diameter inside the bark and tree diameter breast high are equal. Where larch-Douglas fir and lodgepole pine stump heights run consistently higher or lower than 27, 21 and 10 inches, respectively, the above conclusions are not applicable.

THE OPTIMUM STUMP height for larch and Douglas fir appears to be between 26 and 30 inches principally because it is the most convenient working height for sawyers. The average operator does not set a maximum allowable stump height for his sawyers. Therefore, the average heights as shown by Supplemental Table 1, column 24, represent the uninfluenced

judgment of the sawyers. In the ponderosa pine study there was a variation of 17 inches in pine stump heights between the various camps studied. In the larch-Douglas fir study this same variation was only 7 inches indicating a more uniform practice where there is little urge to cut stumps below the comfortable height. The usable wood losses in the larch-Douglas fir study amounted to 266 feet log scale and 125 feet log scale of larch and Douglas fir, respectively, or a total of 485 feet per acre of all species. Supplemental Table 1, part 2, column 40, shows the usable wood volume lost per 1000 feet (net) logged. Larch and Douglas fir losses amount to only 38 and 55 feet log scale per 1000 feet (net) logged compared to 97 feet of lodgepole pine; 83 feet of Engelmann spruce and 380 feet of other species, principally balsam fir. Since larch and Douglas fir were the two major species it is only logical that they should be utilized more closely. Only an occasional balsam fir was cut for sawlogs while numerous trees of small sawlog size were thrown down in felling the other timber and remained unutilized.

Excessive stump heights are not much of a problem in the lodgepole pine type. The study in this type showed a negligible loss of 15 feet of stump wood for each acre logged. The average lodgepole pine stump was 9.8 inches in height and the sawyers cut 58 such stumps per acre. Numerous stumps were cut as low as 6 inches. On areas where

stumps are consistently cut that low the sawyers quite frequently wear knee pads made of untanned sheep skin or deer hide.

NONUSABLE WOOD LOSSES

Nonusable wood losses are of very little interest to the lumberman except from a slash disposal standpoint. The amount of residual wood varies directly with the volume by species logged per acre also with prevailing top utilization practices and the class of material being cut from the trees. Nonusable residual wood in the larch-Douglas fir type amounts to 854 cubic feet or 9.5 cords of all species. This is practically equivalent to the lodgepole pine type where 825 cubic feet (9.2 cords) per acre were found. It is much more than the ponderosa pine type (356 cubic feet, 4 cords) and less than the western white pine (1117 cubic feet, 12 cords). Table A, columns 18 to 25, under the caption "Average for western Montana" shows how nonusable wood was classified. There are 354 cubic feet (column 25) of nonusable residual western larch on the average logged-over acre of the larch-Douglas fir type in western Montana. Of this amount, 181 cubic feet (column 18) is tree wood, mostly tops and broken pieces, 32 cubic feet (column 19) is sound dead wood suitable for fuel, 37 cubic feet (column 20) is sound wood in cull logs, and 104 cubic feet (column 23) is sound wood, except for shake and check, in long butts. In addition to this 354 cubic feet of larch there is also 80 cubic feet

(column 37, Table A) in sound dead standing material on the average logged-over acre in western Montana. This makes a total of 434 cubic feet, or 4.8 cords, of nonusable residual larch wood. Supplemental Table 1, parts 1 and 2, also gives a comparison of nonusable residual wood for a large 17-foot sawlog operation on State of Montana lands (Class I), a large 17-foot sawlog operation on private lands (Class II), and portable sawmill, 8 $\frac{1}{2}$ -foot log, operations on private lands (Classes III and IV). Nonusable wood loss was the least on State lands, a total of but 731 cubic feet of all species (Column 38) compared to 789 cubic feet (Column 38) on the average portable tie mill operation. Utilization is a little closer on State lands than on private lands. Excessive breakage due to felling during extremely cold weather caused the large loss of 1,096 cubic feet of all species (column 38) on the only Forest Service sale area listed (Class IV) in Table 1. Due to the low value of all species in the larch-Douglas fir type nonusable and usable wood losses do not vary widely between the different classes of operations. There is no incentive for close utilization such as exists in the case of the more valuable pines.

Logging in the lodgepole pine type results in a surprisingly large amount of residual nonusable wood. Table B, columns 19 to 32, gives a classification of this material. A total of 825 cubic feet (9.2 cords) of lodgepole pine

nonusable wood remained on the average cut-over acre studied in this type. It is divided as follows: Treewood 207 cubic feet (2.3 cords) mostly tops; deadwood on the ground 80 cubic feet (.9 cords); long butts 23 cubic feet (.3 cords); prop material 240 cubic feet (2.7 cords); lagging material 66 cubic feet (.7 cords); ties 12 cubic feet (.1 cords); telephone poles 16 cubic feet (.1 cords); and sound dead standing material suitable for fuel or stulls, 181 cubic feet (2.0 cords). The amount of nonusable wood per acre of all species in the western white pine type was found to be 524 cubic feet (5.8 cords). The volume of this same class of material resulting from tie operations studied in the lodgepole pine type is 644 feet (7.1 cords) of all species. Since this material contains the fine twigs and needles which are the most inflammable debris the hazard involved in leaving lodgepole slash undisposed would be serious if all risk conditions were identical with white pine. However, they are not. Volume per acre logged on a lodgepole pine tie job is only one-third of the average volume logged in the western white pine type, but top utilization is only to a 9-inch top compared to 6-inch top utilization in white pine type. This fact accounts for the high volume of nonusable wood per acre found on lodgepole pine tie areas.

From time to time attempts at chemical utilization of wood material unfitted for lumber have been made. As yet

none have been especially successful in this region. A few years ago an effort was made to utilize larch long butts for galactan, a water soluble substance used in the manufacture of baking powder, effervescent drinks and pharmaceutical preparations. Before any such enterprise is started it is well to inventory the raw material. During the normal year it is estimated that from 8000 to 10,000 cords of larch long butt material are left in the woods mostly tributary to the Great Northern Railway in northwestern Montana. Some of this material is, of course, subsequently used for fuelwood, so it is not wasted. Material in stumps is also available for galactan extraction. By cutting stumps reasonably sound except for shake and check, to an average height of 7 inches an additional 5000 cords could be secured from this same territory.

RESIDUAL STANDS

LARCH-DOUGLAS FIR and live trees of all associate species were recorded in the study and their volume recorded separately for trees 8 inches and over in d.b.h. The average larch and Douglas fir trees left standing on logged over areas in western Montana in 1930 were 11 and 9 inches respectively in diameter breast high (Table 1, column 8). There were 11 larch and 20 Douglas fir trees per acre of this average size with a total of 42 trees 8" in d.b.h. and over (Table A, column 10) of all species on the average acre logged in

western Montana. Some of these trees are weak and spindly, or contain deformed crowns, but more frequently appear quite thrifty a few years after logging. They form an excellent nucleus for the next crop.

Residual stands on State lands are similar to the average for western Montana. Supplemental Table 1, part 2 (column 31) shows that 39 larch and Douglas fir trees were left on the average acre of logged-over State land compared to 29 trees of the same species on the Class III portable tie mill area. The western Montana average shows 30 larch and Douglas fir residual trees compared to the 39 on State lands. A smaller number by 9 but somewhat larger in average diameter breast high.

Besides these 42 residual trees 8 inches d.b.h. and over the average logged over acre in the larch-Douglas fir type of western Montana contained a total of 152 trees of all species of seedling and sapling size or a total of 194 trees of both classes. These, coupled with the reproduction that invariably comes in after logging are adequate assurance of a future crop PROVIDING SLASH FIRES ARE REGULATED. Co-operative slash disposal is now in effect in Montana. The State Forester now has direct supervision of slash disposal on all operations of the larger companies. All slash is being handled so as to preserve the bulk of the residual trees and reproduction for the next stand. Regulated piling

and burning of slash is, of course, being practiced on Forest Service sale areas which acreage is practically negligible compared to the total annual cut-over area in the larch-Douglas fir type.

Supplemental Table 3 gives a comparison of residual stands by diameter classes (8 inches d.b.h. and over) on logged-over larch-Douglas fir lands for the Forest Service, State of Montana and privately owned areas. Again we find an encouraging situation if slashing and subsequent fires are regulated. The average private area listed on this table shows up the least encouraging. It has a volume of 925 feet per acre contained in 22.2 trees (all species) from 8 inches to 12 inches in d.b.h., inclusive. There are only 1.8 trees per acre above the 12-inch class containing a volume of 192 feet (net) which makes a total per acre of 1117 feet log scale (net) contained in 24 trees. The average for western Montana is considerably better than the foregoing. Thus, it is apparent that there are left on the average acre of cut-over land in the larch-Douglas fir type of Montana a sufficient number of trees 8 inches in d.b.h., and over, and advance reproduction to insure a second crop with a 25 to 40-year start if slashing fires are regulated.

LODGEPOLE PINE residual stands on both private and Forest Service tie cuttings contain the greatest number of trees

per acre in proportion to the volume logged of any of the types studied. Considering lodgepole pine alone (the key tree) a total of 123 residual trees per acre were cruised, which measured 5 inches in d.b.h. and up, or 75 trees measuring 8 inches in d.b.h. and up. The volume of the trees 7 inches in d.b.h. and up was 4470 net log scale (Table 4, column 3). The gross cubic volume of this residual stand of lodgepole then amounts to 1566 cubic feet which is equivalent to 17.4 cords of four-foot wood per acre. There are, however, some old decadent lodgepole pine stands (about 250 years old) which are virtually clean-cut by a tie operation. These constitute only about 25% of the area in the type and as none was being operated at the time of the study they were not included. Residual stands in this class of timber would of course be negligible while the down material, especially dead, would be increased considerably.

It is interesting to note that the average acre in the lodgepole pine study contained a residual stand volume in trees 5 inches d.b.h. and up of 4530 feet net log scale, while only 7400 feet net log scale were logged. The residual stand volume is 61% of the volume logged. This is because trees were utilized for ties only, which precludes use of trees below 11 inches in d.b.h. Note in column 1 of Supplemental Table 4 how the number of trees per acre abruptly decreases at the 12-inch class.

SUMMARY OF UNUSED WOOD

There was a wood loss of 935 cubic feet (10.4 cords) per acre of all species for the average acre logged in the larch-Douglas fir type of western Montana in 1930. For every 1,000 feet of all species logged there is a loss of 47 feet log scale of usable material principally found in smooth straight tops and small sized stumps free from shake and other defects. Development of better woods utilization practices in the larch-Douglas fir type is discouraged by the low lumber selling values of these species. For a number of years the operating margin has been so narrow as to allow an almost negligible amount of stumpage and sometimes less than that. Thus, if stumpage has little or no value there is little incentive for reducing losses in the woods. The portable tie mill offers a partial solution for the larch-Douglas fir type. Practically all of the wood in the tree becomes of equal value when manufactured into ties. This means that coarse material worth as low as \$10.00 per M for lumber is brought up to an \$18.00 or \$20.00 value. However, there is also a reduction in value of the select material which under normal conditions sells for from \$27.00 to \$30.00 per M for lumber. This situation offers a splendid opportunity for development of selective logging and log grading practices. These developments would enable the operator to convert only those trees and logs to ties in the tie mill in the woods as are suited for ties. Logs

containing the required amount of select and more suitable for lumber production could be diverted to the big sawmill plant along with the more valuable ponderosa pine and spruce. Considerable study would, no doubt, be necessary before this development could take place, but it seems feasible upon a superficial analysis and is worthy of study. Unusually low lumber prices prevailing during the last two years have resulted in numerous suggestions for the financial rehabilitation of the lumber industry. One cry has been - utilize only that portion of the tree that can be converted to the desired product (usually lumber) at a reasonable profit with allowance for stumpage. Evidently this practice was followed during the hey-day of the Michigan logger. I have at hand data from a study made on a ponderosa pine area which was first logged in 1887 and subsequently in 1927. Data on utilization lengths were compared as a matter of interest. In 1887 twenty-four (24) inch ponderosa pine trees were cut into sawlogs for an average length of 40 feet compared to 66 feet in 1927. Perhaps we will return to this. However, for the sake of conservation and good forestry, it is hoped that we do not.

In the lodgepole pine study the total wood loss of all species amounted to 929 cubic feet (9.2 cords) on the average acre studied. For every tie cut there remains on the ground 4 linear feet of lagging material and one (1) linear foot of prop material. Stumpage values in the lodgepole pine type have always been consistently higher than in the larch-Douglas

fir type. Average annual lodgepole pine stumpage prices varied from \$1.05 to \$3.69 during the period 1916 to 1925 compared to a maximum of \$2.00 per M for larch and Douglas fir during this period. Thus, we see with stumpage prices at these levels there is a greater incentive for closer woods utilization in the lodgepole pine type especially in the matter of stump heights.

Regardless of our efforts for closer and a more balanced economic utilization of larch, Douglas fir and lodgepole pine, we cannot lose sight of the low intrinsic value of these species in an already glutted lumber market. Approximately 65% of the volume in the larch-Douglas fir type in the United States is in federal and state ownership while at least 90% of the lodgepole pine stumpage is in public ownership. With the exception of forced exploitation to salvage insect and fire-damaged timber deferred utilization seems to be the logical solution of all larch-Douglas fir and lodgepole pine woods utilization problems.

WOOD MATERIAL PER ACRE LEFT AFTER LOGGING
LARCH - DOUGLAS FIR TYPE
WESTERN MONTANA
TABLE A.

STUMP DATA.

SPECIES	Basis	No.	Hgh't Ins.	Average	Per Cent	Usable	Net Volume
	No. of	Per	Ave. Stump	D. I. B.	Stumps	Stp. Material	Logged
	Stumps	Acre	Woods Run	Woods Run	Defective	Ft. B. M.	Ft. B. M.
	1	2	3	4	5	6	7
Larch	605	21.6	27.0	17.5	84	118	6390
Douglas Fir	319	11.4	21.0	15.6	50	49	2070
All Species	1145	40.9	--	--	--	202	9470

D.I.B. - Diameter inside bark; Stp. - Stump.

LIVE UNCUT TREES -- 8 INS. D. B. H. and UP and REPRODUCTION

SPECIES	D.B.H.	Basis	No. Trees	Number and Volume Ft. B. M.				Repro-
	Ave. Tree	No. of	per	Thrifty	Unthrifty	Total	Total	duction
	Ins.	Trees	Acre	Net	Gross	Net	Gross	Number
	8	9	10	11	12	13	14	15
Larch	10.6	300	10.7	613	653	101	456	714
Douglas Fir	9.2	549	19.6	788	790	34	85	822
All Species	--	1190	42.5	1902	1964	186	667	2088

CUBIC FEET OTHER MATERIAL LEFT IN WOODS

SPECIES	Sound	Dead	Cull	Long Butts		Pulp	Total
	Tree Wood	Wood	Logs	Bd. Ft.	Bd. Ft.	Cubic Ft.	Cubic
	Cubic Feet	Cu. Ft.	Cu. Ft.	Gross	Net	Net	Feet
	18	19	20	21	22	23	24
Larch	181.5	31.7	36.8	664	60	104.2	--
Douglas Fir	94.1	28.3	9.8	91	4	13.6	--
All Species	355.7	127.5	49.9	766	64	119.4	17.5

FEET B.M. SAWLOG MATERIAL LEFT IN WOODS and CULL DATA

SPECIES	Net Scale						Defect	Per Cent
	Butt	Middle	Top	Total	Scale	Scale	Scale	Woods
	Scale	No.	Scale	No.	Scale	No.	Scale	Cull
	26	27	28	29	30	31	32	33
Larch	17	.4	44	1.1	87	2.9	148	323
Douglas Fir	8	.3	32	1.1	36	1.3	76	37
All Species	47	1.1	95	2.7	141	5.1	283	375

DEAD TREES LEFT STANDING

SPECIES	Number	D. B. H.	Cord-
	Per	Ave. Tree	wood
	Acre	Inches	Cubic Ft.
	35	36	37
Larch	2.2	10.6	80
Douglas Fir	4.0	9.2	50
All Species	10.1	--	184

SUMMARY OF WOOD LOSSES

SPECIES	Cubic Feet Total of	Ft. B. M. Total of	Ft. B. M. Usable
	Material Other Than	Saw Log Material and	Wood Loss per
	Merch. Sawlogs and	Usable Material in	M. Feet (Net)
	Stump Material	High Stumps	Logged
	38	39	40
Larch	434.2	266	38
Douglas Fir	195.8	125	55
All Species	854.0	485	47

WOOD MATERIAL PER ACRE LEFT AFTER LOGGING
 LODGEPOLE PINE TYPE
 SOUTHWESTERN MONTANA
 TABLE B.

STUMP DATA

SPECIES	: Basis	: No.	: Hgh't Ins.	: Average	: Usable	: No. Ties
	: No. of	: Per	: Ave. Stump	: D. I. B.	: Stp. Material	: Logged
	: Stumps	: Acre	: Woods Run	: Woods Run	: Ft. B. M.	:
	: 1	: 2	: 3	: 4	: 5	: 6
Lodgepole	: 268	: 57.9	: 9.8	: 13.2	: 15	: 235.0
All Species	: 269	: 58.	: --	: --	: 15	: 235.5

D. I. B. - Diameter inside bark; Stp. - Stump.

LIVE UNCUT TREES -- 8 INS. D. B. H. and UP

SPECIES	: D.B.H.	: Basis	: No.	: Volume	: Ft. B. M.	: Total	: Total	: No.
	: Ave.	: No. of	: Trees	: Thrifty	: Unthrifty	: Net	: Gross	: Ties
	: Tree	: Trees	: Per	:	:	: Ft.	: Cu.	: Ft.
	: Inches	: Acre	: Net	: Gross	: Net	: Gross	: B. M.	: Ft.
	: 7	: 8	: 9	: 10	: 11	: 12	: 13	: 14
Lodgepole	: 8.4	: 2048	: 160	: 5010	: 5010	: 1170	: 2540	: 6180
All Species	: --	: 2125	: 166	: 5158	: 5158	: 1170	: 2540	: 6328

CUBIC FEET OTHER MATERIAL LEFT IN WOODS

SPECIES	: Sound	: Dead	: Long Butts	: Props	: Logging	: Ties	: Poles and	: Total
	: Tree	: Wood	: Bd. Ft.	: Bd. Ft.	: Cu.	: Lin.	: Cu.	: Piling
	: Wood	: Cu.	: Gross	: Net	: Ft.	: Ft.	: Ft.	: Feet
	: Cu. Ft.	: Ft.	:	: Net	:	:	: Ft.	: Ft.
	: 19	: 20	: 21	: 22	: 23	: 24	: 25	: 26
Lodgepole	: 207.0	: 80.0	: 152.0	: 50	: 23.3	: 951	: 240	: 576
All Species	: 207.3	: 80.	: 152.0	: 50	: 23.3	: 952	: 240	: 580

* FEET B. M. SAWLOG MATERIAL LEFT IN WOODS and CULL DATA

SPECIES	: Net	: Scale	: Defect	: Per Cent
	: Butt	: Middle	: Top	: Total
	: Scale	: No.	: Scale	: No.
	: 33	: 34	: 35	: 36
Lodgepole	: 586	: 6.3	: 73	: 1.2
All Species	: 586	: 6.3	: 73	: 1.2

* These are not regional average figures. They represent an area where large butt logs were left for a subsequent portable tie mill operation.

DEAD TREES LEFT STANDING

SPECIES	: Number	: Cord
	: Per	: Wood
	: Acre	: Cu. Ft.
	: 42	: 43
Lodgepole	: 15.7	: 181
All Species	: 15.8	: 181

SUMMARY OF WOOD LOSSES

SPECIES	: Cu. Ft. - Total of	: Ft. B. M. Total of	: Lin. Feet Prop	: Lin. Ft. Logging
	: Material Other Than	: Sawlog Material and	: Material Left in	: Material Left in
	: Merch. Sawlogs and	: Usable Material in	: Woods for Each	: Woods for Each
	: Stump Material	: High Stumps	: Tie Cut.	: Tie Cut.
	: 44	: 45	: 46	: 47
Lodgepole	: 824.6	: 15	: 4.0	: 1.0
All Species	: 825.3	: 15	: 4.0	: 1.0